

THURSDAY, OCTOBER 26, 1876

WEATHER CHARTS AND STORM WARNINGS

Weather Charts and Storm Warnings. By Robert H. Scott, M.A., F.R.S., Director of the Meteorological Office. With numerous Illustrations. (London: Henry S. King and Co., 1876.)

"DO you understand these *Isobars* on the weather charts?" we asked an amateur meteorologist who was showing us the curves which represented his own barometrical observations. "Well, I cannot say I do," he replied; "they are very interesting and curious, twisting one day one way, next day another way, and the third day turning all round." It is this not uncommon ignorance which the Director of the Meteorological Office seeks to dispel. His object is "to explain to the reader what he can learn from a careful study of the information published in the newspapers or in the daily weather reports," and for this end he has "attempted to give to the public an account of the actual state of our knowledge at present." He then exposes to public gaze all the mysteries of the Weather Office; he draws aside the curtain, and shows us

*His "copper-plate, with almanacks
Engraved upon 't, and other knacks;
His moondial, with Napier's bones,
And other constellation stones."*

The following are among the most important of these talismans:—The cyclonic law of the northern hemisphere—that if we turn our backs to the wind the higher barometer will be on our right hand, the lower barometer on the left; that the force of the wind is connected with the closeness of the isobars to a considerable extent; that we never have a storm unless the difference of pressure at two stations in the British Isles is less than half an inch of mercury. That cyclones proceed, in general, eastwards, their approach being frequently heralded by a tendency of the isobars to form closed curves; and that this is first seen in most instances towards the west coast of Ireland. These conclusions differ little from those which Dr. Lloyd deduced in 1854 from his study of atmospheric variations in Ireland. Anti-cyclones which have their greatest pressure at the centre are most frequently connected with light winds and fine weather.

All the deductions are illustrated by charts and curves from self-registering instruments, which enhance the value of this useful little volume.

Nothing, however, is more interesting than to see how the theories of meteorological writers for the last half century stand the test when confronted with the daily observation and practical application of facts. We cannot open a work on meteorology without finding all the great phenomena of varying atmospheric pressure ascribed to the action of the sun's heat in producing vapour and expanding the atmospheric gases. Thus the barometer is said to fall in a country because it is warmer there than in neighbouring countries, the more expanded air overflowing (thus causing a wind in the upper regions) towards the colder country, where the barometer rises; on the other hand, a surface wind is generated from the

colder to the hotter region. But the most important of all movements admitted by every one were the polar and equatorial currents. The chief of the Meteorological Office treats the views of the great authorities to whom we have referred, in the following manner:—

"For many years it has been the fashion to say that all cold winds flowed from the poles to the equator, forming the so-called polar currents, and becoming the trade winds when they approached the tropics, while the warm winds flowed from the equator to the pole, forming the equatorial currents or anti-trades" (p. 20).

It is very like heresy to speak of "the fashion" and the "so-called polar currents," when their existence has been an article of faith accepted everywhere. It is true no one could say he had observed these currents; and we, who have sought for them in our own latitudes and within the tropics, have insisted that they were neither to be seen nor felt where their effects were supposed to be the greatest. No doubt one of our greatest writers on this subject put the equatorial atmosphere into one cylinder, surrounded by warm water, and the polar atmosphere into another, with an ice-cold jacket, and showed that if the stopcocks preventing communication at the top and bottom of the two cylinders, that is, the upper and lower passages from the equator to the pole, were opened, the currents referred to could be made visible. This, we think, is an illustration of what Mr. Scott, immediately after the passage quoted above, refers to as "right in principle." The atmosphere has also been supposed to have an upper surface like a lake, down which the expanded gases slide. Every condition in nature—density, distance, temperature, viscosity (but those unknown to us) have been under-estimated, exaggerated, or neglected.

The author's conclusions, from his long watch of atmospheric variations, are somewhat different. He says:—

"The motions of the atmosphere are found to be mainly regulated by the distribution of barometrical pressure over the globe, the particles moving from the regions where the pressure is high to those where it is low," &c. (p. 21).

"Wind is always connected with some disturbance of the pressure of the atmosphere, and it will be at once understood that its existence is due to the tendency of an elastic fluid like air to regain the condition of equilibrium from whence it has by any means been disturbed," &c. (p. 27).

These conclusions are just the reverse of those usually entertained, especially with reference to tropical cyclones where the diminution of central pressure is attributed to the winds, and the movement in which is illustrated by a whirlpool caused by the difference of velocities, or opposite directions of motion of contiguous currents of water. In the cyclones of these latitudes we must suppose Mr. Scott to give, as the result of his experience, that the winds *follow* and do not *precede* the diminished central pressure.

In whatever way the subject is considered there will always remain many facts to some of which the author alludes, which cannot easily be explained by the action of cyclonic winds as causes of diminished pressure; and in these cases the question arises, what is the cause of the latter? This is no mere idle question, it is connected with the whole subject of weather prediction.

Thus, we may ask, with a fluid so mobile as the air, why are there atmospheric basins at the centre of which during months the mean pressure is half an inch of mercury below that in neighbouring regions? Why, in all the disquisitions on fluid equilibrium, are the constant low pressures in the antarctic regions south of 60° neglected? How shall we account for the permanent barometric depression in the neighbourhood of Iceland referred to by the author (p. 74)? And to come to our own country, how will cyclonic winds explain the fact that the pressure of the atmosphere diminishes on the average of the whole year at the rate of one-tenth of an inch of mercury for 4° of latitude as we proceed northwards, and increases at the same rate as we move southwards?

There are evidently atmospheric conditions with which we are unacquainted and for which no parallel can be found by experiments with air shut up in a box, in which it has been "the fashion" of some meteorologists to travesty our atmosphere. The variations of temperature and vapour tension which have been employed to explain everything occupy a very subsidiary place in weather predictions. Yet the effects of varying temperature on our atmosphere are to a great extent unknown to us; the only action taken into consideration has been that connected with expansion; but even expansion may affect properties of the atmosphere which have not as yet been investigated. Thus we know that the magnet which is expanded by heat loses magnetism, but of the way in which heat may affect the magnetism, the electricity, and the viscosity of the atmosphere we know nothing, and we are equally ignorant to what extent the pressure of the atmosphere may be affected by its varying electric state through humidity or otherwise. The satisfaction with which insufficient hypotheses have been received has retarded the progress of research for other causes; and it is a good sign of future advancement that a practical meteorologist like the author has left boldly the beaten track and given indications that we must try elsewhere.

Returning to the practical view, Mr. Scott says:—

"Various theories have been propounded to account for storms . . . but none of them have met with general acceptance as yet. We must, therefore, only take things as we find them, and endeavour to make the best of them" (p. 28).

This, in all senses, philosophic view of the subject, is also that of necessity—to make the best of what we know. To do this the author points out the importance of having more stations and more telegrams. As the great mass of storms approach us from the west, more stations are required, especially on the west coast of Ireland; stations also are required in the interior for the purpose of ascertaining the rate of progress of any threatening signal. This demand, there can be no doubt, will be granted, together with the means to procure any telegrams which particular cases may seem to require.

When we remember the great advantage of these storm warnings, not only to ourselves, but, as Mr. Scott has shown, especially to the ports on the western littoral of Europe (where our sailors and ships are also to be found), we trust every means will be given to make them more certain.¹

Though the Director of the Meteorological Office is forced to employ the knowledge he now has, he does not

seem to feel less the necessity of obtaining more. In spite of the large proportion of successful warnings, he says, in the conclusion of his work, that weather telegraphy is "a branch of investigation which can hardly be said to have got out of the leading strings of infancy as yet" (p. 146). Although the infant stumbles little, all things considered, yet some astonishment has been expressed that it has not grown more rapidly.¹ This astonishment, we believe, has been due in part to an underestimate of the labour and difficulties connected with meteorological research. Every one considers he can commence as master in this subject, if he has only the observations or the instruments to make them with. This error is not confined to those ignorant of all science; it is partaken by many men eminent in other departments, who would smile if their own subjects were treated in a similar way by any tyro, whatever his knowledge otherwise. The low view thus taken of the qualifications necessary for successful inquiry in this branch of science has certainly not been supported by the results of importance which should have been so easily obtained, although meteorologists have counted in their ranks some of the most eminent mathematical physicists.

One of the great causes of the slow growth of meteorology is to be found in the long, laborious, and, not unfrequently, unfruitful calculations necessary in seeking laws from great masses of observations. The results obtained, if the inquiry has been successful, may be expressed in a few figures, which may not appear to have the slightest practical value. Few men qualified to direct the lines, and to devise the methods, of investigation have the time to devote to such ungrateful, and to a great extent mechanical, work. Hence the readiness with which speculative views, chamber theories, have been proposed instead, and these, when supported by men of talent, have made research to appear unnecessary or have thrown it into false channels.

Meteorology, it appears to us, will be best advanced by neglecting at present all theories, unless as far as they indicate new objects of investigation; and by the devotion of qualified workers, each searching in his own way. Also it should not be forgotten that it may not be possible to tell, *à priori*, in what direction the laws are to be sought, on which satisfactory weather predictions may be founded. It may be in some connection between the variations of the earth's magnetism and those of our atmosphere that warnings which will outrun the telegraph may be found; or it may be in some apparently insignificant fact discovered in a neglected corner. All the knowledge we now possess in meteorology would be practically valueless for storm warnings but for the useless-looking experiment of Oersted with a magnetic needle and an electrical current.

We should notice a few cases in which, it appears to us, some slight changes may be made with advantage in a second edition of the work before us. In his desire to be brief, the author has not been quite exact in his remarks on the dry and wet thermometers; thus, p. 5:—

"Suffice it to say, the greater the difference between the readings of the two thermometers, the drier the air,

¹ Mr. Scott gives a table showing that in 1873 and 1874 warnings were justified by subsequent gales 45.3 times in a hundred, and by subsequent strong winds 33.4 times per cent., or in all nearly four times in five (p. 139).

and when the two thermometers read alike, the atmosphere is exceedingly damp."

This statement is not likely to give any very definite idea of the conclusions which may be drawn from the readings of the thermometers, and the difference may be less at one time than another, and yet the air be "drier."

In cyclonic systems, the author says, "the air circulates more rapidly [than in anti-cyclonic], causing strong winds, and appears to flow in towards the centre, so that it must naturally be supplied from below and ascend in the centre." Here the rapid circulation of the air is said to be the cause of the wind. It is also said elsewhere that it is calm in the centre. Is it meant as a result of observation that the air flows towards the centre? and is it a result of observation that the air (naturally or not) rises in the centre?

We have already alluded to the little use of the tension of vapour in "storm warnings." With reference to one case, we find: "The absence of rain is very noticeable during the early period of the gale; the reason for this absence can be seen from the fact of the great distance [on the curves given] between the wet and dry thermometers." The difference is about 3° with the dry thermometer near 50°, and the wind blew "pretty steadily from S.S.W. for twenty hours" (p. 68). If the fact that it did not rain was an unusual one under the circumstances, and if that depended on the difference of the thermometers, the question seems to us only changed to what was the reason of the difference?

We do not always read the curves as the author has done, nor always agree with his reasoning from them; and in some cases, as p. 72, where one cyclone has passed eastwards, north of a station, leaving a N.W. wind, and is followed by another also passing north, the author has not made it very clear why the wind should back to S.W., to S., and S.E., through the action of the S.E. wind of the second cyclone meeting the N.W. of the first.

These queries and suggestions do not affect the general character of the book, which we can recommend as a useful and instructive companion in the study of weather charts, and for the comprehension of storm-warnings as they are issued from the Meteorological Office. It is much to be desired for the many who will not read this work, yet cast a curious eye on the isobars in the newspapers, that some condensed statement of the general rules should occasionally accompany them.

JOHN ALLAN BROWN

GEIKIE'S GEOLOGICAL MAP OF SCOTLAND

Geological Map of Scotland. By Archibald Geikie, LL.D., F.R.S., Director of the Geological Survey of Scotland; Murchison Professor of Geology and Mineralogy in the University of Edinburgh. (Edinburgh and London: W. and A. K. Johnston, 1876.)

SINCE the publication of the last edition of the sketch-map by Sir R. I. Murchison and Prof. Geikie, no general geological map of Scotland has, so far as we are aware, been issued, while those older than the sketch-map rather served as guides to localities where minerals and rocks were to be found, than afforded any clue to the sub-

divisions of geological time represented by our ancient formations. During the last twelve years, however, materials have been accumulating which have daily rendered the sketch-map more and more inadequate to the purposes for which it was originally designed, and it had obviously become necessary either to issue a new edition, or to "reform it altogether." Considering all things, and especially that he could no longer avail himself of the co-operation of his late colleague, Prof. Geikie has, wisely we think, decided on the latter course. The comparatively large scale adopted (ten miles to the inch), gives room for a number of details which had to be omitted from previous maps.

The publication, for the greater part of the south of Scotland, of the Geological Survey Maps on the scale of one-inch and six-inches, reduces to some extent the operations of the compiler to the selection of as much of the details as his map gives him room to insert. At the same time there are many points regarding the relations of distant deposits which can be better seen on reviewing the work as a whole than during the progress of detailed mapping, and on some of these, as we shall presently point out, Prof. Geikie takes up an independent position.

The northern half of Scotland is in a very different state as regards our knowledge of its geology. Here and there, it is true, competent observers have selected choice bits, and have worked them out with a thoroughness that leaves little to be desired. But a great part of the Highlands is still unknown to geologists, or only known in so far as concerns its comparatively simple glacial phenomena. For this region we have to consult "geognostic travels" of the beginning of the century, and put the best construction on them that we can. It is not, therefore, to be wondered at that this portion of the map is somewhat vague. The metamorphic rocks of the Highlands offer difficult problems to the chemist and physicist, as well as to the geologist; and whoever attempts to unravel their structure as a whole, must probably be content to work for some years in the dark, and with the consciousness that he may not see the issue of his own labours.

Till recently the Southern Uplands were pretty much in the same state as the Highlands, but the detailed work of the geological survey, and a few private observers, has filled up this great blank and rendered possible a comparison of the structure of the Silurian rocks there with those of England and Ireland. On the map now before us, are laid down, for the first time, all the more important graptolite bands which for a hundred miles, at least, appear at intervals among the upturned Lower Silurian strata between the Rhinns of Galloway and the Tweed, while a marginal section explains how the Llandeil beds, after folding over and over, are unconformably succeeded near the northern edge of the uplands by Caradoc basins, and on the south by rocks supposed to be Upper Silurian. It thus appears that on the southern side of Murchison's "axial beds" only a small part of the northern series is repeated, the place of the Moffat shales not being reached at the point where the Upper Silurian rocks begin.

North of the Uplands a notable feature of the new map is the rearrangement of the Old Red and Carboniferous boundary-line. The identity of the bright-red, sharp, siliceous sandstones below the cement-stone series of the